they had developed out of a couple of the more posterior pairs of external gills, the girdles to which they were attached representing the skeleton of the corresponding branchial arches.

Mr. Kerr in the course of his paper controverted the view that the external gills were secondarily developed adaptive structures in the groups in which they occur; he also dealt with the difficulty that most true external gills contain no cartilaginous axis, pointing to the barbels of *Xenopus* with their cartilaginous axis, and to the rod of cartilage found by Budgett projecting into the base of the external gill of the hyoid arch of the young crossopterygian.

Tuesday afternoon's meeting of the Section opened with a lantern lecture by Major R. Ross on the story of malaria. He dealt in detail with the history of the various stages in the discovery and establishment of the mosquito theory, from the first fact, the discovery of the malarial pigment in 1849, to Manson's crucial experiment in 1900. He then passed to the prevention of malaria and other mosquito-borne diseases, and gave an account of the experiments now in progress in Sierra Leone and Lagos.

The session ended with three exhibitions—Dr. Francisco P. Moreno showing photographs of fossils in the La Plata Museum, Prof. Gilson a new sounding and ground-collecting apparatus, and Dr. J. Rankin a new orientating apparatus for the Cambridge microtome.

During the last few days of the meeting three of the zebra hybrids bred by Prof. Ewart were on view in the quadrangle (medical) adjoining the sectional meeting room. These hybrids were: (1) "Remus," the largest of the three, was born May, 1897, dam a 14-hands bay half-bred Irish pony. The mane of "Remus" was all but removed last April. (2) "Sir John," the small stout one, was born June, 1899. His dam is a yellow and white Iceland pony. "Sir John" probably reproduces fairly accurately the coloration of the primeval common ancestor of the horses and zebras. (3) "Birgus," the slender hybrid, was foaled May, 1900. His dam is a chestnut 14-hands polo pony. In 1898 this polo pony had twin hybrids, one of which goes extremely well and quietly in harness.

It is impossible to conclude even a brief account of the zoology of the meeting without at least a passing reference to the excellent volume on the natural history of Glasgow and the west of Scotland issued under the title "Fauna, Flora and Geology of the Clyde Area" as one of the three handbooks prepared by the local committee. A large number of specialists have collaborated in the production of the lists and articles, the result being a work of great completeness and of more than local interest, and of permanent value.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE work of Section E at the meeting at Glasgow maintained the feature which has been noticeable for the last two or three years; the number of "popular" papers was comparatively small, while papers presenting the results of detailed research, or laying down foundations of future work, formed a distinct majority. Although the change has led to a marked diminution in the average numbers attending the meetings of the Section, it must be regarded as satisfactory, inasmuch as it indicates an increase in the annual output of scientific work by geographers in this country, and the fact is all the more gratifying in view of the difficulties in the way of geographical research, to which Dr. Mill drew attention in his presidential address. Dr. Mill laid his finger upon the true reason why "the few attempts which have been made in this country to promote the study of geography or to diminish the discouragements to geographical research have had but slight success" when he pointed out that "amongst the not inconsiderable number of teachers of geography in the universities and colleges of Great Britain there is not one man who receives a salary on which he can live in decent comfort so as to devote all his time, or a substantial part of it, to geographical research; and the same is true of every official of all the geographical societies." Until there are properly equipped centres offering adequate opportunities for research as well as teaching, we cannot expect students of geography to receive the intellectual stimulus which research alone can give, nor can we develop a system of geographical teaching suited to our special educational needs and methods, and capable of satisfactory extension to our schools.

Following the delivery of the president's address on Thursday morning, Mr. E. G. Ravenstein read a paper on Martin Behaim. Martin Behaim fills a place of some prominence in the history of geography on three grounds: firstly, the historian João de Barros, writing in 1539, states that he was a pupil of Regiomontanus, and was appointed a member of a committee which devised a method of "navigating by the sun"; secondly, Behaim claims to have commanded a vessel in Cão's second expedition; and thirdly, during a visit to Nürnberg in 1490–93, he superintended the manufacture of a terrestrial globe, which survives to this day. Mr. Ravenstein seriously doubts the first claim, rejects the second, and fully admits the third.

The tenth and final report of the Committee on the climate of Tropical Africa was also presented. In this report, drawn up by Mr. Ravenstein, abstracts of the meteorological observations received during the year are published, and a review is given of the work of the Committee since its first appointment in 1891. In completing its labours, the Committee recommends that where local provision is not made for the publication of observations, the registers should be forwarded in future (through the Foreign or Colonial Office) to the Meteorological Council or to the secretary of the Royal Meteorological Society. Copies of the "Hints to Observers," published by the Committee, may be obtained from the secretary of the Royal Meteorological Society.

Dr. A. J. Herbertson read a paper on the morphological divisions of Europe, in which he pointed out the inadequacy of the ordinary physical map for many of the purposes of the geographer. The paper was illustrated by a new "morphological" map of Europe, based primarily on the work of Suess, in which Europe was divided into physical regions, taking into account, not merely configuration, but composition and structure, and by a few well-chosen examples, such as the comparative structure of the south-east of England, the Seine basin, and the German Jura, Dr. Herbertson showed the undoubted value of maps of this type for purposes of both research and teaching.

The first paper in the afternoon was one by Mr. G. G. Chisholm, on geographical conditions affecting British trade. After illustrating his contention that geographical conditions, although often disregarded, were really important factors to be taken into account, by pointing out that Glasgow remained unimportant, both commercially and industrially, until the development of Transatlantic trade, Mr. Chisholm discussed the effects which improvements in means of communication, electric transmission of power, and other modern developments, are likely to produce in the trade of Great Britain as compared with that of other countries.

Prof. Alleyne Ireland read a paper on the influence of geographical environment on political evolution, in which he discussed the possibilities of native government within the tropics, concluding that while the natives of the tropics are not deficient in intellectual power, their "climatic discipline" renders them unfitted to play the part of legislators or responsible administrators or to maintain a government sufficiently stable to admit of proper commercial development.

The Rev. Thomas Lewis gave an account of journeys in Portuguese Congo, in the course of which he has collected much valuable topographical information.

Friday morning was devoted to the geography of Scotland, and the proceedings afforded gratifying evidence that in spite of difficulties Scottish geographers are prosecuting research along various lines with vigour and success.

The first paper was one by Prof. G. F. Scott Elliot, on the effects of vegetation in the Valley and Plain of the Clyde. The general characters of the Clyde Valley in seven separate divisions were described— the sub-alpine, heather and peat, sheep pasture and arable districts; the Falls of Clyde canyon, the valley below the falls, and the flat and alluvial plains—and the successive stages in the formation of the valley slope were traced in a number of instances. It was shown that a perfect series of transitions can be found from the vertical scaur cut by the river to the continuous steep slope characteristic of the neighbourhood, and that the formation of the slope, in its various stages, was controlled by the vegetation.

Miss Marion Newbigin gave an account of a scheme which has been undertaken by the Scottish Natural History Society at the suggestion of Sir John Murray. It is proposed, firstly, to arrange, in a readily available form, references to papers already published on the natural history of the Forth Valley, including its botany, zoology and geology; and, secondly, the Society proposes to utilise its various sections and the labours of its individual members in the acquisition of a mass of detail in regard to the existing organic conditions in the valley of the Forth.

Prof. W. G. Smith described the methods and objects of the botanical survey of Scotland inaugurated by his brother, the late Mr. Robert Smith. The difficulties of grouping the flora comprehensively into "plant associations" having been got over, and the proper cartographic methods elaborated by a number of experimental surveys, it remains to carry out the work on the large scale. Great interest was taken in Prof. Smith's paper, and in the course of the discussion which followed Major Craigie gave the satisfactory assurance that when the survey is put on a definite basis it will receive assistance from the Board of Agriculture in the way of supplying details.

In the afternoon Dr. Francisco Moreno read an important communication on the anthropogeography of Argentina, in which he summed up the existing evidence as to the origin and distribution of different races of mankind in South America, and stated a number of problems awaiting further investigation. Mr. Hesketh Prichard gave an account of his journey in Patagonia, undertaken recently for the *Daily Express*. At the close of the meeting, Mr. Reclus-Guyou exhibited a specimen of the maps on natural curvature prepared by M. Elisee Reclus. These maps are drawn on a sheet of aluminium stamped to the curvature of a globe whose radius has the proportion to that of the Earth of the natural scale of the map.

On Monday morning Captain Lemaire gave an account of the Belgian expedition to Ka-Tanga under his command. The first part of Captain Lemaire's paper described the scientific results of the expedition, amongst the most important being an exhaustive investigation of barometric methods of determining altitudes in low latitudes; the second part consisted of an exhibition of part of the excellent collection of photographs made by the expedition. The expedition mapped more than 6600 kilometres of itinerary on a large scale, and one of the most remarkable features of the expedition was that "they left behind them no cause for complaint, or any ground for ill-will, among the native populations." Captain Lemaire's work was very appropriately described as a model and a guide for all modern explorers in Central Africa. In connection with this paper an exhibition of water-colour sketches by M. Dardennes, artist to the expedition, was held in the gallery of the Glasgow School of Art.

Dr. Vaughan Cornish presented the first report of the Committee on terrestrial surface waves, which dealt chiefly with observations of snow waves and ripples, and snow drifts and snow caps, made by Dr. Cornish during last winter in Canada. Considerable difficulties were met with in obtaining satisfactory photographs of the details of snow surfaces, but Dr. Cornish's admirable slides showed that these have been successfully surmounted.

Mr. H. N. Dickson read a paper on the mean temperature of the atmosphere and the causes of glacial periods, in which he drew attention to the fact that any change which may have occurred in the mean temperature of the atmosphere was probably accompanied by change in the temperature gradient between equatorial and polar regions, and therefore by modifications of the atmospheric circulation. It was suggested that this had not been sufficiently taken into account in discussing glacial and other phenomena connected with secular changes of climate, and that by taking it into consideration a comparatively small gain or loss of heat would suffice to produce the changes of temperature deduced from the geological record, while the changes in circulation at the earth's surface would account for many peculiar features of distribution.

On Monday morning a joint meeting was held with Sections C (geology) and D (zoology), to discuss the objects and methods of the scientific study of the lakes of the British Islands with special reference to the scheme of survey about to be carried out by Sir John Murray and Mr. Lawrence Pullar. Dr. Mill, who presided, read the following letter from Sir John Murray explaining the scope of the proposed survey, and stated that it had been undertaken as a memorial to the late Mr. F. P. Pullar:—

"I am sorry it is not possible for me to be present at the meeting of the British Association this year. I am very pleased to learn that a discussion has been arranged with reference to the proposed bathymetrical, physical, and biological survey of the fresh-water lakes of the United Kingdom. I have not, as yet, definitely settled anything with regard to the undertaking, but my idea is to endeavour to obtain the cooperation of three young university men who would take a real interest in the investigation and be likely to make something out of the researches in the way of experience and reputation; one to be a physicist, one a zoologist, and one a botanist. I propose to offer for the first year a salary of 100*l.* and expenses while actually engaged in field work at a rate a little better than is given to members of the Geological Survey. The principal work will be to sound the lakes and prepare the bathymetrical charts. While this is going on observations will be made concerning the temperature of the water at different depths and different seasons of the year, as well as how the distribution of temperature in the lakes is affected by wind and other conditions. Observations will also be made on the distribution of plants and animals in the different lakes at various depths and seasons, and on the deposits at the bottom of the lakes. The geological structure of the district in which the lakes are situated, the rainfall, and other allied phenomena will likewise receive attention. I would expect those who take part in the work at a salary to give their whole time to these investigations, and to work under my direction, but they will receive full credit for their work, and will be allowed to publish results in their own names. It may be possible to receive assistance from others who cannot give their whole time to the researches, and also to make collections and observations for those who are engaged in the study of special branches of limnology. It is probable that I will arrange to publish separately the results obtained in each catchment as soon as the survey of each basin has been completed, and then to publish a general account of the fresh-water lakes of the United Kingdom when the practical work of the survey has been finished. I propose to commence the organisation of the undertaking soon after my return to Scotland, and I hope to complete the whole work in five or six years."

A full debate followed, in which both geologists and biologists took part. Mr. John Horne intimated that the Geological Survey would, given the formal approval of the Board of Education, place any information in their possession at the disposal of Sir John Murray and his colleagues, and Colonel D. A. Johnston, of the Ordnance Survey, expressed his warm interest in the undertaking. A formal resolution expressing the great gratification of the meeting at the decision to carry on the work under the direction of Sir John Murray, and its sense of the munificence of Mr. Lawrence Pullar, was moved by Mr. Horne, seconded by Mr. Peach, and carried unanimously.

The proceedings on Monday afternoon opened with the report of a Committee—consisting of Sir T. H. Holdich, Colonel G. E. Church, Mr. E. G. Ravenstein and Mr. H. N. Dickson —which was appointed at the Bradford meeting to draw up a scheme for the survey of British protectorates, particularly in Africa. The Committee specially urges the importance of laying down a main triangulation so as to provide fixed points from which local surveys by explorers and others may begin, and of providing means of training native surveyors and topographers similar to those existing in India, such surveyors to be attached to exploring and similar expeditions as opportunities offer.

An important paper by Dr. R. Bell, of the Geological Survey of Canada, was next read by Mr. Mackinder. This paper dealt with the topography and resources of northern Ontario, or "New Ontario," and described the immense region lying north-west of the line of Lake Nipissing and the French River. The paper was accompanied by material for the construction of an adequate map of the district, which has not hitherto been represented with any detail.

Mr. A. Lawrence Rotch described some results of the exploration of the upper strata of the atmosphere by means of kites, and discussed specially the application of the method at sea. On land the wind is sometimes insufficient to raise the kites, but on board a steamship the artificial wind due to the motion of the vessel obviates this difficulty, and by altering the course relatively to the direction of the wind the action of the wind on the kite can be regulated to a very considerable extent. Successful experiments have been made at sea on board an Atlantic liner, and the value of extended investigations in the tropics, made from a ship which could be specially detailed for the purpose, can hardly be overestimated. The Association has appointed a strong Committee, with a money grant, to cooperate in these experiments.

The report of the Committee on changes of the land-level of the Phlegræan Fields, drawn up by Mr. Günther, was presented. Mr. Günther's work being still in progress, the report was of a preliminary nature, but it is satisfactory to note that the materials for the investigation have proved more valuable and abundant than was anticipated.

On Tuesday morning Mr. W. N. Shaw, F.R.S., exhibited a complete series of the weather maps published daily by various countries. Most of these bore the date January 1, 1901; others June 1, 1901. The list is interesting as showing the position of this branch of meteorology at the beginning of the twentieth century:—Austria, Bavaria, Belgium, British Isles, Denmark, France, Germany, Holland, Italy, Portugal, Russia, Saxony, Spain, Switzerland, Algeria, Australasia, Canada, India, Bay of Bengal, Japan, Mexico, United States, Roumania.

The rest of the morning was devoted to papers on the Antarctic expeditions. Dr. J. Scott Keltie described the organisation and equipment of the National Antarctic Expedition, and Dr. H. R. Mill gave an account of the voyage of the *Discovery* as far as Madeira, to which point he accompanied the vessel for the purpose of working out the details of the meteorological and oceanographical routine. Mr. W. S. Bruce then read a paper on the methods and plans of the Scottish National Antarctic Expedition, in which he announced that sufficient funds had been subscribed, entirely by Scotsmen, for one complete year's work in the Antarctic. It is proposed to purchase a whaler of about five hundred tons, and to leave this country in about a year's time. The ship will carry a scientific staff of five, five officers, and a crew of twenty. An attempt will be made to push as far south as possible in the Weddell Sea, and the deep reported by Ross in lat. 68° S., long. 13° W., will be specially investigated. The expedition will confine itself almost entirely to marine work, and it is not intended to winter in the ice.

In the afternoon Mr. H. Yule Oldham read a paper on the experimental demonstration of the curvature of the earth's surface. Mr. Yule Oldham has repeated Wallace's Bedford level experiment on the old Bedford River between Welney Bridge and Denver Bridge, a perfectly straight stretch of six miles. A mark was set up midway between the bridges, at the same height above water level as marks on the two bridges, and found to stand six feet above the line of sight. Records of the experiment have been obtained by the use of a special telephotographic lens.

Dr. R. Logan Jack then gave an account of an expedition in Western China, in which the Chengtu Plain was crossed five times, and a good deal of mapping done of the margins of the plain, and the courses of the rivers reaching it from the north. At the Maha gold mines the party received information of the massacres at Pekin, and were advised to make for Burma. Bhamo, in Upper Burma, was reached after many difficulties.

A paper, by Mr. Archibald Little, on the Crux of the Upper Yang-tse, was read by Mrs. Little. The paper contained an extremely graphic account of, an ascent of the river during the flood season, and the condition of the country and of river navigation was compared with that obtaining during the winter.

The last paper was by M. Galeron, designer of the great celestial globe at the Paris Exhibition, on the representation of the heavens in the teaching of cosmography. After pointing out the difficulty experienced by the student in realising the apparent positions and motions of the heavenly bodies from a study of the ordinary celestial globe, in which the celestial sphere was represented as seen from the "outside," M. Galeron exhibited and described an apparatus in which a celestial globe is made of thin muslin, and sufficiently large for the head of the observer to be placed at the centre. The apparatus, which can be constructed very simply and cheaply, enables the chief phenomena to be demonstrated with great clearness.

It is noteworthy that the Artisan's Lecture this year, although geographical, was not an account of travel and exploration, but an exposition of the application of geographical principles. In his lecture on "The Movements of Men by Land and Sea," Mr. Mackinder showed how the progress of civilisation has been affected by the configuration of the Earth's surface, and pointed out the profound changes going on in political and social life under our eyes, as the result of the development of the great ocean lines of communication and of the transcontinental railways. The lecture was a perfect illustration of the aims and methods of the "new geography," and should do much to make those better understood and appreciated.

EDUCATIONAL SCIENCE AT THE BRITISH ASSOCIATION.

THOUGH the new Section of the British Association was only appointed for a year, the success of the meetings at Glasgow was of so decided a character that the Section will probably become a permanent part of the Association. It can scarcely be said at present that an educational science exists, but the statement of methods and results, and the discussion of the relationships between principles and practice, apart from all political considerations, should do something to organise the conclusions of people who have given serious attention to educational problems. The Section will exert the greatest influence in connection with scientific studies; and there is no reason why it should not lead to improvements in methods of teaching as valuable as those which have been produced by the scheme for a course of work in chemistry, drawn up by Dr. H. E. Armstrong for the British Association Committee on the methods of teaching chemistry. It is not too much to say that this scheme started a revolution which gathers strength every day. The system of science instruction by didactic methods still exists in places, but only because the machinery for carrying on the work on more rational principles has not been obtained. Wherever the object is education, the methods of research have been introduced, and it is recognised that real scientific knowledge can only be gained by individual experience.

Educational Experiment and Research.

Sir John Gorst accepted the principle of research in education in his address as president of the Section, and Dr. Armstrong emphasised it in an early paper. The power of research, the art of acquiring information for oneself, must, he pointed out, be cultivated in all because it is the power on which advance in life depends. The chief work of the Section will be to teach this doctrine, and impress it upon the teachers. A science of education must be shaped, and a national programme must be constructed in which research methods are encouraged and teachers are trained to have sympathy with them. The humanists must enter into an alliance with the naturalists, and the union should take place on equal terms. At present our educational system is entirely one-sided. The schools still at best suffer science; they do not love it and the old universities do not even regard it as a necessary element of culture.

Reform will be brought about by the development of workshop and laboratory methods. The experimental method of teaching is adapted to the curiosity and activity of the average boy, and should be the basis of instruction at the earliest stages. Prof. L. C. Miall gave strong support to the experimental method, which he described as the most complete embodiment of the methodised art of trying, of ignoring failures and improving successes, and perpetually going on until the goal was reached. This is the habit it is desired to set up and which will take an important place in future educational work. Sir Michael Foster emphasised the view that science is not learnt in the lecture room, but in the laboratory. The first aim should be to teach a boy to think, and this can be done by practical work properly arranged. It has been stated over and over again that pupils who have been prepared by the older learning take to science more readily when they are brought to it than those who have been trained from the very beginnings in science. This, Sir Michael said, was easy to understand, because teachers in the humanities have been trained to teach for generations, while men of science are only now beginning to learn how to teach.

Methods of teaching are of great importance, and the British Association can be the means of producing improvements in them. Prof. H. L. Withers, however, in a paper on the scope of educational science, expressed the opinion that before deciding how this or that subject should be taught it is desirable to formulate a theory of the curriculum, that is, to arrive at some conclusion as to the proportional value of subjects. Mr. P. A. Barnett also took this view, the main argument of his paper being that the criterion of success in education must be, not what people have been taught to do or to make, but what they are and how they bear themselves in all the relationships of life. But the educational value of a subject even considered from this point of view depends upon the scope of the subject and the methods of teaching, so that a reasonable curriculum cannot be drawn up until a decision has been arrived at as to what is implied by the name of each subject.